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N-S shortening during orogenesis in the Mt Isa Inlier: the preservation of W-E structures and their tectonic and metamorphic significance.

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N-S shortening during orogenesis in the Mt Isa Inlier: the preservation of W-E structures and their tectonic and metamorphic significance

Volume I

Thesis submitted by

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Australia

STATEMENT OF SOURCES

Declaration

I declare that this thesis is my own work and has not been submitted in any form for another degree or diploma at any university or other institution of tertiary education. Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references given.

Mohammad Sayab

March, 2005

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March, 2005

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THESIS FORMAT

This thesis consists of four independent sections (A to D), which have been prepared as individual papers for international journals. Section A, which contains confidential geophysical dataset of pmd*CRC, will be submitted in January 2005 after disclosure release. Sections B to D have been submitted. Details of the submission process are given in the first page of each section. Each section contains its own set of references and figures, which results in some of the figures being repeated. The thesis is presented as two volumes. Volume I contains text and reference lists for each section. Volume II contains figures, tables and appendices.

Appendices are arranged according to each section (A – D). Appendix – E contains sample catalogue with reference to Australian Map Grid (AMG) coordinates, zone 54. The catalogue also contains information regarding thin sections used in this study, polished sections, rocks used for major element XRF analysis and rock chips and blocks.

THESIS ABSTRACT

Mesoproterozoic Mt Isa inlier of NW Queensland exhibits complex tectonometamorphic history that is generally considered to result from low-pressure/high-temperature (LP/HT) metamorphism with an anticlockwise pressure-temperature-deformation path. Yet studies regarding the nature of the P-T history and tectonic regime that led to such a LP/HT signature have been quite limited. A detailed FIA (**F**oliation **I**ntersection/**I**nflection **A**xes preserved in the porphyroblast**s**) analysis combined with textural relationships and P-T pseudosections, using key localities across the Eastern Fold Belt of the Mt Isa Inlier, has resolved the cause of the LP/HT signature. Measurement of FIAs in the Eastern Fold Belt has revealed phases of deformation and metamorphism that could not previously be distinguished from one another. Both the ‘asymmetry switch’ and ‘FitPitch’ FIA measurement techniques have been applied to key localities of polymetamorphosed and multiply deformed Eastern Fold Belt, and they yielded the same result. These independent techniques have revealed (1) W-E trending structures that formed during N-S bulk shortening (O_1) and N-S oriented structures that formed during W-E bulk shortening (O_2) in the Eastern Fold Belt, (2) the presence of separate periods of metamorphism associated with each direction of bulk shortening, and (3) the crustal scale tectonic processes associated with polymetamorphism. The structural overprinting relationships do not support previously suggested non-coaxial west vergent, nappe-style folding in the region. A progressive succession of overprinted FIA trends reveals a clockwise rotation of the principal direction of bulk shortening with time. This requires a radical shift of relative plate movement from N-S to W-E during development of the

north Australian craton in the Mesoproterozoic (*ca* 1.60 and 1.50Ga). Significantly, O_1 porphyroblasts preserving W-E FIAs exhibit mineral textures of Barrovian style, whereas O_2 formed porphyroblasts preserving N-S FIAs are Buchan in style. This supports the emplacement of the Williams/Naraku Batholiths after O_1 around the onset of O_2. Higher-pressure garnet cores, modeled in MnNCKFMASH P-T pseudosections preserved early W-E FIAs and formed during O_1. This was followed by decompression and then low pressure – high temperature (LP/HT) metamorphism when N-S FIAs were preserved within porphyroblasts. This is further supported by the presences of at least two distinctive generations of staurolite and kyanite that grew both before and after andalusite/cordierite. Middle to upper amphibolite facies metamorphic conditions occurred during O_1 with crustal thickening followed by fast erosion and near-isothermal decompression leading to LP/HT conditions. This was followed by O_2 and a second period of middle- to upper- amphibolite facies metamorphism that obliterated and/or obscured the tectonometamorphic signature of primitive O_1 in the matrix of most rocks. This history appears to correlate better with that observed in the southwest United States, which may have been located against the NE of the Australia at this period in time.